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Soybean Seed Germination Experiments

Summary
The students will design and conduct their own experiment based on some general background information they receive. This experiment will be based on seedling germination and plant growth. Students will come up with their own variables to test and then conduct their own experiment. They will create a poster display of their research project to be presented to the class.

Targets
• Determine the basic requirements for plant growth.
• Create questions to test for a scientific experiment.
• Follow the scientific method to design and carry out an experiment.
• Analyze data to develop a conclusion to validate/deny a hypothesis.
• Correct or control variables to improve experimental quality.

Background
Some plants can reproduce asexually, or by producing clones. Many other plants produce seeds through sexual reproduction. For these plants, survival depends on germination of seeds and viability of young plants. If a seed germinates in the wrong place or at the wrong time – then life is over for that individual. In this lab, student groups will design and conduct experiments on seed germination to explore the effects of abiotic and biotic factors on plant survival.

Plants require certain factors to grow successfully. They need abiotic factors such as water, light, nutrients, a substrate to grow in, and often a suitable temperature. If these are not optimal for a plant, then its ability to germinate and grow can be reduced. They can also be affected by biotic factors such as the age of the seed, predation or mold growth. When the students begin to design their experiments, they should control everything but one variable.

Materials
Activity 1: Group Discussion Series
- Paper

Activity 2: Seed Germination Experiment
- Experimental Design worksheet
- Soybean Seeds (Different ages, same variety)
- Cups & Potting soil or Paper towels & Plastic bags
- Water
- Ruler

May need depending on experiments:
- Colored saran wrap as light filter
- Desk lamp
- Soda, Milk, Fertilizer (Miracle Grow)
- Gravel
- Whatever else the students come up with that is easily obtained
- Poster paper (1 sheet per group)
- Graph paper
- Sticky notes

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Teacher Prep for Activity

Prep will vary from day to day; the students will need their notebooks once they start to plan their procedure and question. The day that the experiment is set up, all of their requested materials should be set out and available to them. They also need to have soil and containers to place their seeds into, depending on their procedure. Make copies of worksheets.

Activity 1: Group Discussion

1. Scientific Method
   What are the steps of the scientific method? Discuss the scientific method with your lab partner(s) and outline the steps of the scientific method in a flowchart on a piece of paper.

2. Seed Germination
   Create a Driving Question Board (DQB) by writing "Seed Germination" in the center of a sheet of paper. Answer the following questions and place the answers in an appropriate location on the DQB in a flowchart configuration.
   A. What do seeds need to germinate?
   B. What are different ways that abiotic factors could affect seed germination? (Soil, water, light, temperature, etc.)
   C. What are different ways that biotic factors could affect seed germination? (seed age, predation, digestion).

Activity 2: Seed Germination Experiment

1. Student lab groups create a group name and a hypothesis to test. (Remember, a hypothesis must be logical, testable, and justifiable.
2. Pass out the Experimental Design worksheet
   - Chose an appropriate control for your experiment (half of the seeds should be controls). Control seeds are handled just like the other seeds, except that they do not receive the treatment.
   - Make sure the hypothesis is something they can test. Students can measure the number of seeds germinated and/or the growth rates of plants after the seeds germinate. This can easily be calculated by dividing height of the plant by the time they have been growing.
   - Now have each group design a procedure to test their hypothesis. Have them write out their hypothesis, materials, procedure (including what they intend to measure), and how they will compare their data to their control on their worksheet. One copy needs to be turned in from each group to make sure that it is a testable hypothesis and their procedure is something that can be done and the materials can be obtained.
   - After reviewing the procedure for each experiment (a sample procedure has been included below), have the group look at the adjustments that need to be made. Have the groups edit their procedure on their worksheet.
3. Each group should send someone to get the materials they need to set up their experiment.
4. The student groups should follow their own procedure to set up their experiment. Have each student keep their own notes for their experiment because they will be putting together a poster at the end of their experiment.

5. This experiment will be on going, with the students watering/monitoring their seeds and plants as often as they decide in their procedure (This could occur every day, every other day, etc.)
6. After data collection is complete (probably about 2 weeks), students will summarize their data in charts and graphs. These charts and graphs can be made on a computer

or by hand on graphing paper.

- Remember the components of a good graph.
  - X axis – the independent or treatment variable
  - Y axis – the dependent variable
  - Use the proper scale – the scale should allow you to cover most of the page
  - Clearly label the title, axis, values, and units
  - Bar graphs are best for qualitative response variables
  - Line graphs are best for quantitative variables
  - Use a legend to clarify variables

7. Have the students write a lab report based on their experiment. Handout the Lab Report Guidelines worksheet and review it with the students. Have the students complete their lab report on a computer and include data charts/graphs in the report.
8. The students will then make a poster of their experiment to put on display for the class. The poster should include their hypothesis, a brief version of their procedure, and their results, including the graphs they made. An example has been included below.
9. Place the posters on display in the classroom. Each group will get up in front of the class and give a short 2-3 minute presentation on their research poster. Afterwards, the students can do a gallery walk, providing constructive and positive comments about each poster by writing it on a sticky note and placing it on the poster.

Assessments
Student assessment will be done based on the completeness of Experimental Design, data collection, and analysis of data, their poster, and their presentation.

Extension Activities
Have the students design a new experimental design for seed growth and not germination, or continue on with their experiments to see how the treatment affects the growth of the seedlings.

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Sample Write-Up

Hypothesis: Seeds germinated and grown in soda will not grow as well as those grown in water.

Materials:

Seeds
Paper Towels
Water
Dr. Pepper
Plastic Bottles, bags or Petri dishes
Ruler

Procedure:

1. Select 10 seeds as the variable and 10 seeds as the control.
2. Place each set of seeds on a paper towel on the bottom of a plastic bottle or petri dish. One for the control and one for the variable.
3. Dampen each paper towel with same amount of the liquids (Dr. Pepper and water).
4. Check paper towels daily (except weekends) and moisten as needed.
5. Record the length of time it takes for each seed to germinate (# of days) and a seed will be considered ungerminated after 1 week of no growth.
6. After the seeds germinate, growth will be determined by measuring the height of the plant with a ruler.
7. This will be done for the next week.
8. After the data is collected, the mean number of days it takes a seed to germinate will be recorded for both the variable and the control. This will be displayed in a bar graph, with the x-axis having two categories (water and Dr. Pepper) and the y-axis being the average number of days.
9. The median will also be determined and displayed in a table for the average days to germinate.
10. The average growth for each seedling will be determined and displayed on a similar bar graph. The median will also be determined for seedling growth.

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Experimental Design Worksheet

Group Name:_____
Date:_____

Partners: _____

Hypothesis:
Testable statement

Control:

Variable:
Manipulated variable (element of change)

Materials:
List

Procedure:
Steps of the experiment

Data:
Data Chart & Graph!

Results:
Did your data support your hypothesis? Why or why not? What factors could have been possible sources of error in this experiment? What could you do to improve the design, data collection, etc. from your experiment and increase the validity of your results?